
DYNAMIC STABILITY CONTROL SYSTEMS

INTRODUCTION

Dynamic Stability Control (DSC III version 5.3) was introduced on the 1998 Model Year E38 and E39 - 540 vehicles. For Model Year 1999, the system is enhanced with additional control functions and a new combined rotational rate/lateral acceleration sensor as version 5.7.

It continues to be offered as standard equipment in the E38 and E39 - 540 models. The new functions are titled as the Dynamic Braking System and include the:

- Dynamic Brake Control (DBC)
- Maximum Brake Control (MBC)

The DSC III 5.3 system for the E38 and E39 is supplied by Bosch and the complete system operation is covered in the 1997 Model year Update - Part Two training manual. The new functions of operation of the DSC III 5.7 system will be covered in this training manual.

Dynamic Stability Control (DSC III) is also being introduced for the E46 vehicles as optional equipment. This system is supplied by ITT Teves, however many of the system components and features are similar to the Bosch system. The full function description and operation of the Teves system will be covered in this training manual.

DYNAMIC BRAKING SYSTEM

The dynamic braking system is designed to enhance the braking control of the DSC for the driver of the vehicle. The dynamic braking control and maximum braking control are functions that are programmed into the control electronics of the DSC with no additional hardware changes.

DYNAMIC BRAKING CONTROL (DBC)

The DBC function is designed to provide the maximum braking force available during rapid (panic) braking situations. The DSC control module looks at the inputs from the brake pedal switch and the signal from the brake pressure sensor on the master cylinder. The criteria for activation of DBC is how rapidly is the brake pressure built up with the brake pedal depressed. The total criteria required for DBC activation includes:

- Brake switch ON
- Brake pressure build up > threshold value
- Vehicle road speed > 5MPH
- Vehicle not in reverse
- Not all wheels in ABS regulation

If the threshold for DBC activation is achieved, the DSC control module will activate a pressure build up regulation phase through the hydraulic unit. The pressure at all wheels is increased up to the ABS regulation point. This occurs even if the driver does not achieve the ABS regulation point with the pedal.

The rear axle brakes are controlled with select-low regulation and the front axle brakes are controlled individually. ABS regulation will continue until the driver releases the pedal and the pressure in the master cylinder drops below the threshold value stored in the DSC control module.

MAXIMUM BRAKE CONTROL

The MBC function is also designed to enhance a driver initiated braking procedure. The MBC will build up the pressure in the rear brake circuit when the front brakes are already in an ABS regulation cycle. The additional braking pressure at the rear wheels will shorten the stopping distance. The following criteria must be met before the DSC control module will activate MBC:

- Both front wheel brakes in ABS regulation
- Vehicle speed > 5 MPH
- Vehicle not in reverse
- DBC and pressure sensor initialization test OK
- Rear wheels not in ABS regulation

BOSCH DSC III - 5.7 COMPONENTS

With the exception of the following, all components of the DSC - 5.3 are carried over and their functional operation remains the same.

- Control Module/Hydraulic Unit
- Rotational Rate/Lateral Acceleration Sensor
- Master Cylinder Pressure Sensor

CONTROL MODULE HYDRAULIC UNIT

The control module is now integrated into the hydraulic unit as one compact unit. This reduces the size and wiring required for DSC operation. Additionally the motor relay and valve relay have been replaced by solid state final stages in the control module. The hydraulic unit continues to use:

- Two pre-charge solenoid valves
- Two changeover solenoid valves
- Four intake solenoid valves
- Four outlet solenoid valves
- One return pump



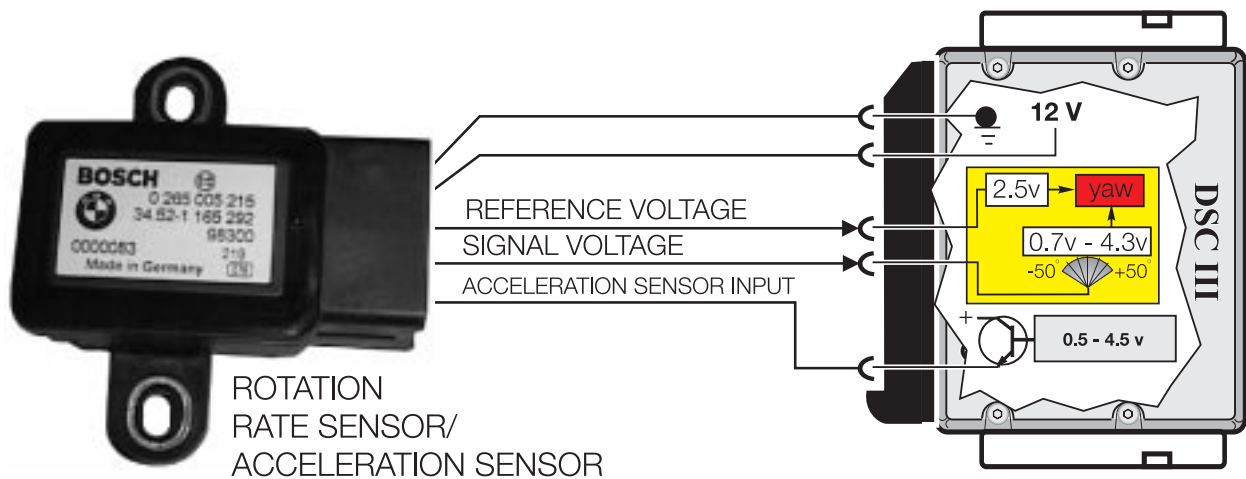
ROTATION RATE/TRANSVERSE ACCELERATION SENSOR

Located under the driver's seat, the rotation rate and transverse acceleration sensor have been combined into one unit. The new sensor is smaller in size and weight and is isolated from chassis vibrations through its rubber mounting.

The sensor provides the same information as the two separate sensors used on the DSC 5.3 version. It receives power and ground from the DSC control module.

For rotational speed, the sensor produces a reference signal of 2.5 volts and a linear voltage signal from 0.7 to 4.3 volts. This linear voltage input signal is used by the DSC control module as the degree of rotational rate (yaw).

The sensor also produces a linear voltage signal for the lateral acceleration (G-force) that ranges from 0.5 to 4.5 volts. The DCS control module uses this input to determine the side forces acting on the vehicle for DSC regulation.

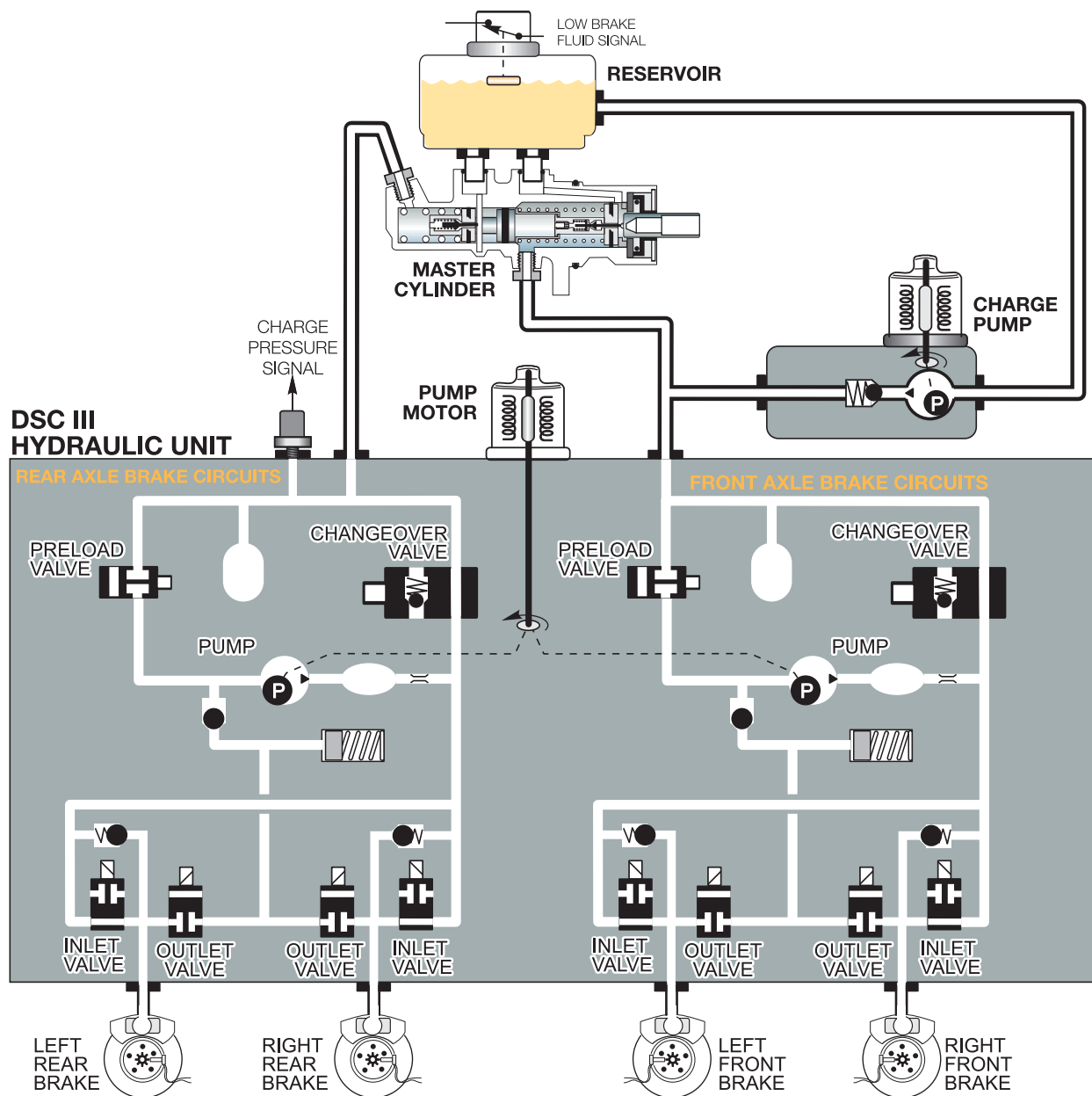


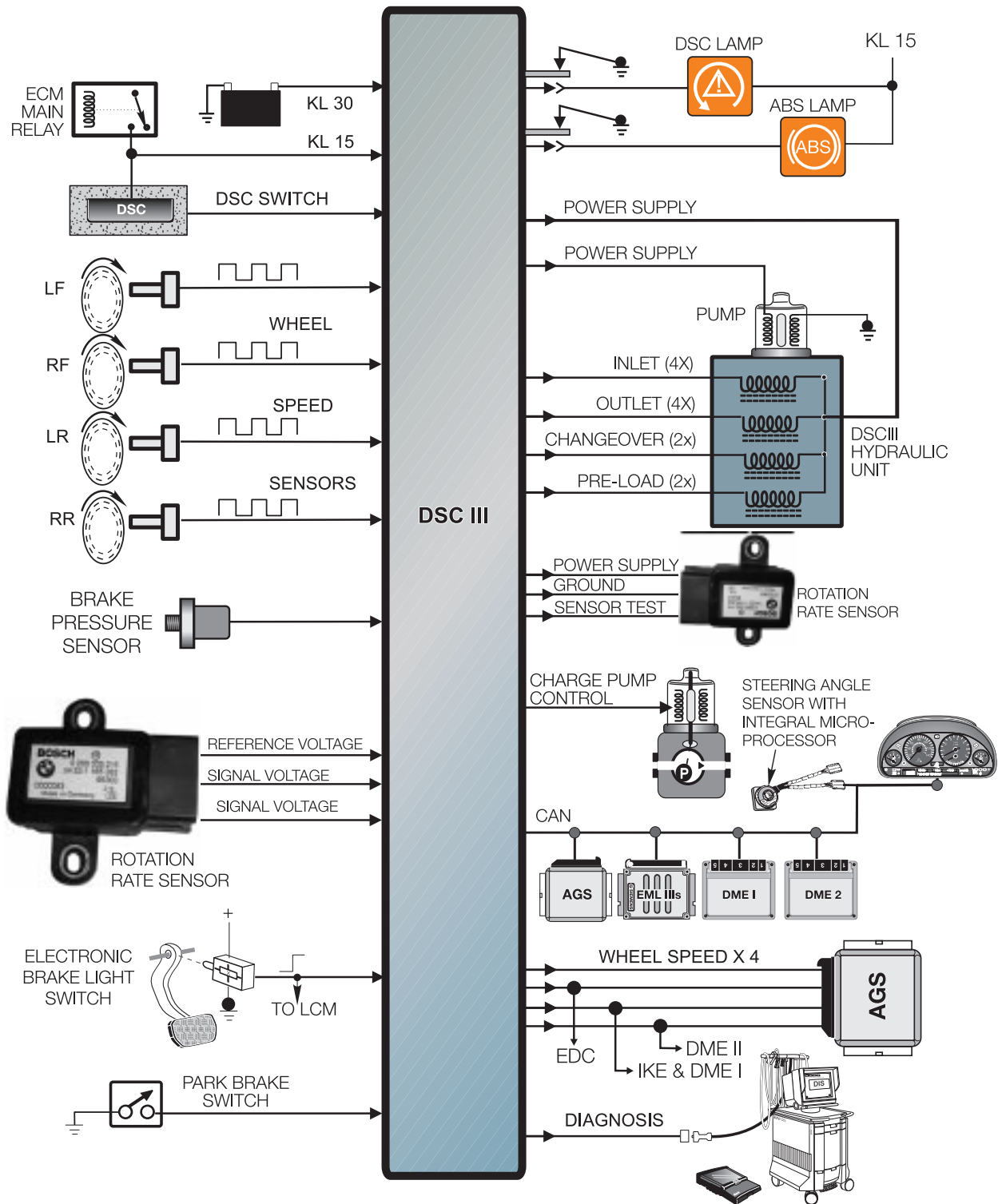
BRAKE PRESSURE SENSOR

A brake pressure sensor is installed in the master cylinder to determine the degree of pressure build-up for Dynamic Brake Control. It is installed in the front axle brake circuit.

The sensor receives its power supply from the DSC control module and produces a linear voltage input signal ranging from 0.5 to 4.5 volts depending on how hard the brakes are applied.







E46 DYNAMIC STABILITY CONTROL (DSC III)

INTRODUCTION

The DSC III system is being introduced as an option for the E46 beginning with Model Year 1999 production. The system is similar to the DSC III being used on the E38 and E39 vehicles, however it is manufactured by Teves for use in the E46.

The system incorporates all of the features of the previous Teves slip control system and adds the lateral dynamic control of the DSC III system already installed on the E38/E39s.

The Teves DSC system is designed to maintain the lateral locating forces for following:

- ABS braking control
- ASC +T traction control
- DSC - Dynamic Stability Control for oversteer and under steer conditions

SYSTEM OVERVIEW

The E46 DSC III system consists of the following components:

- Control module/Hydraulic Unit (combined)
- Four wheel speed sensors
- Charge pump
- Tandem Brake Master Cylinder
- Steering Angle Sensor
- Yaw Rate Sensor
- Lateral Acceleration Sensor
- Two Brake Pressure Sensors
- Brake Fluid Level Switch
- DSC Button
- DSC Warning Indicator
- CAN Interface (DME/AGS)

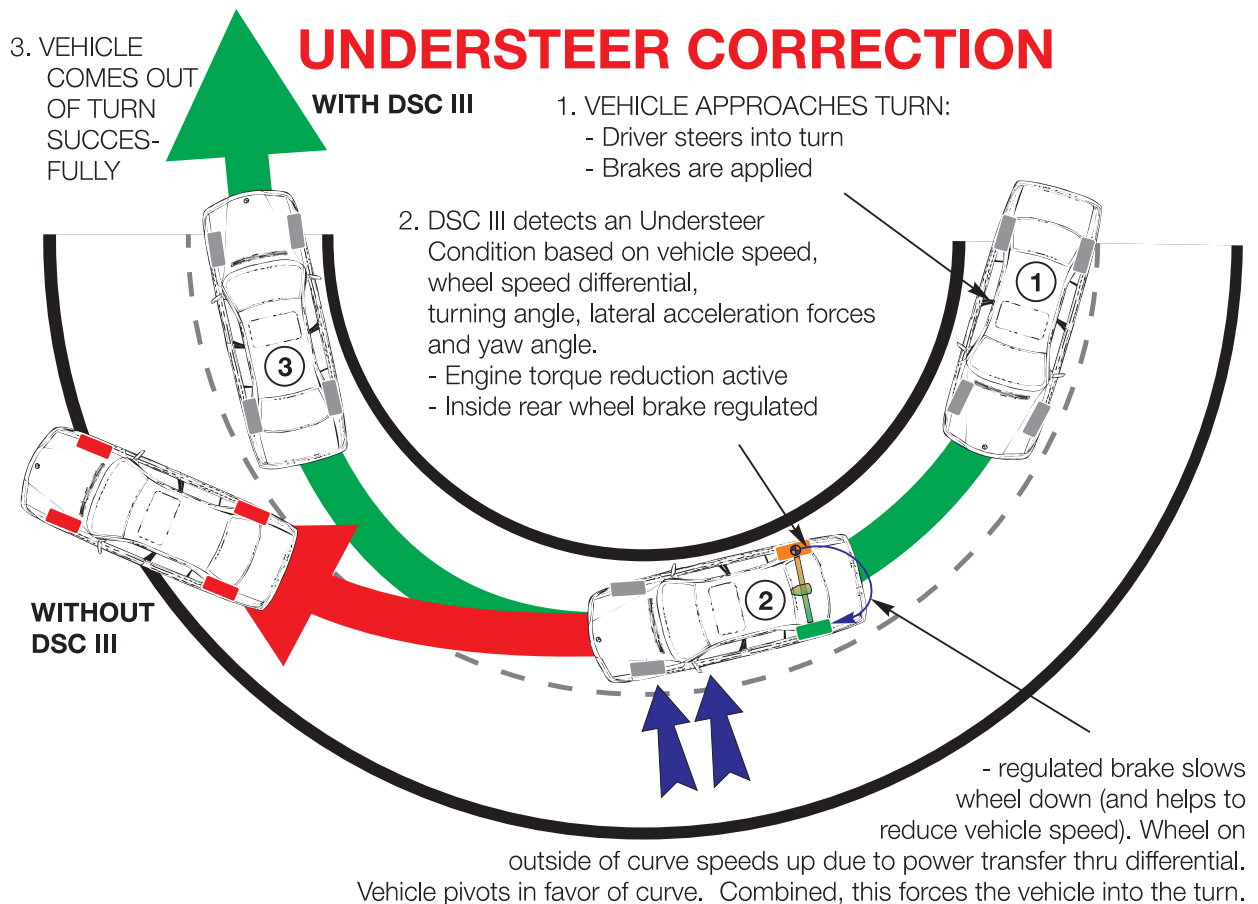
DCS CONTROL OVERVIEW

The Teves DSC system maintains the lateral location forces during all phases of operation through;

- ABS - Hydraulic intervention preventing the wheels from locking during hard braking
- ASC +T - Engine drive torque reduction and/or hydraulic intervention on the drive wheels to ensure straight line traction (acceleration - driving and deceleration)
- DSC - Engine drive torque reduction and/or hydraulic intervention on any wheel brake during cornering to minimize oversteer and understeer conditions

DSC control can aid the driver in controlling the vehicle while driving but can not overcome the laws of physics if the vehicle is being driven beyond the range of DSC control.

UNDERSTEER/OVERSTEER CONDITIONS

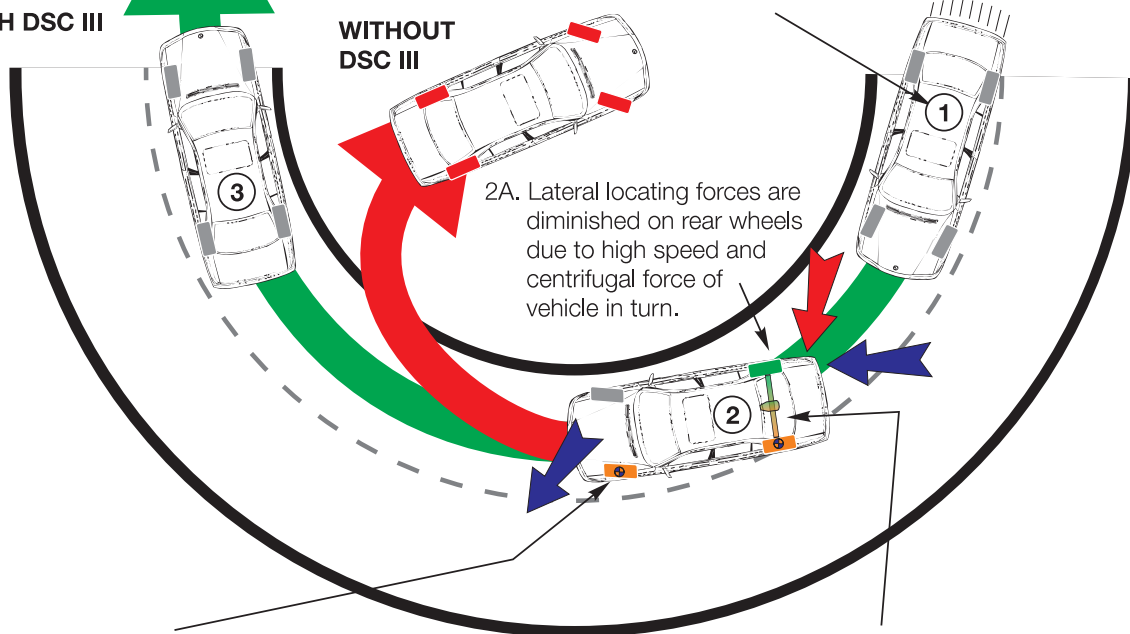


OVERSTEER CORRECTION

3. VEHICLE COMES OUT OF TURN SUCCESSFULLY

WITH DSC III

WITHOUT DSC III



1. VEHICLE APPROACHES TURN AT HIGH RATE OF SPEED:
- Driver steers into turn and applies brakes to slow down.

2A. Lateral locating forces are diminished on rear wheels due to high speed and centrifugal force of vehicle in turn.

2D. The torque reduction and rear brake regulation should stabilize the vehicle at this point. If not the left front wheel has a high degree of lateral locating force and is momentarily regulated.

This action deliberately causes the wheel to shed a calculated degree of it's locating force. This counteracts oversteer yaw at this wheel and also aids in slowing the vehicle down to correct it.

2B. Driver tries to compensate by oversteering which diminishes lateral locating force even further. Simultaneously, rear of car starts to slide out.

2C. DSC III determines an OVERSTEER condition. Engine torque is reduced via CAN Bus signalling. Outside rear wheel is momentarily regulated to counteract severe yaw angle (also helps to reduce drive torque further.)

COMPONENTS

CONTROL MODULE/HYDRAULIC UNIT

The control module is installed in the engine compartment on the right side next to the strut tower.

Both the control module and the hydraulic unit are replaceable as separate components.

All processing functions for ABS/ASC or DSC regulating functions are carried out in the one control module. The module is linked to the CAN bus for communication with the DME and AGS control modules. Additionally the CAN bus is used for communication with the steering angle sensor and for illumination of the ABS and DSC indicator lamps in the instrument cluster.

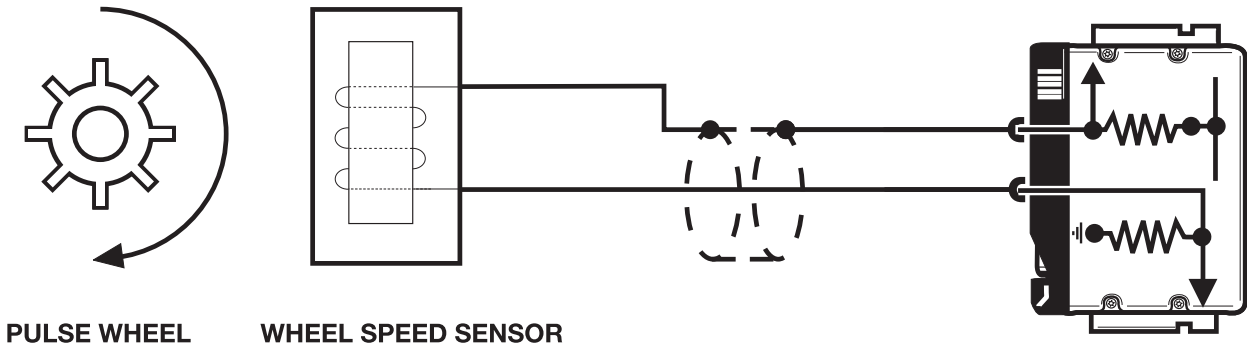
The hydraulic unit consists of the following:

- Four inlet solenoids
- Four outlet solenoids
- Two changeover solenoids
- Two charge solenoids



WHEEL SPEED SENSORS

The E46 DSC III system uses the wheel speed sensors from the ASC system.



BRAKE LIGHT SWITCH

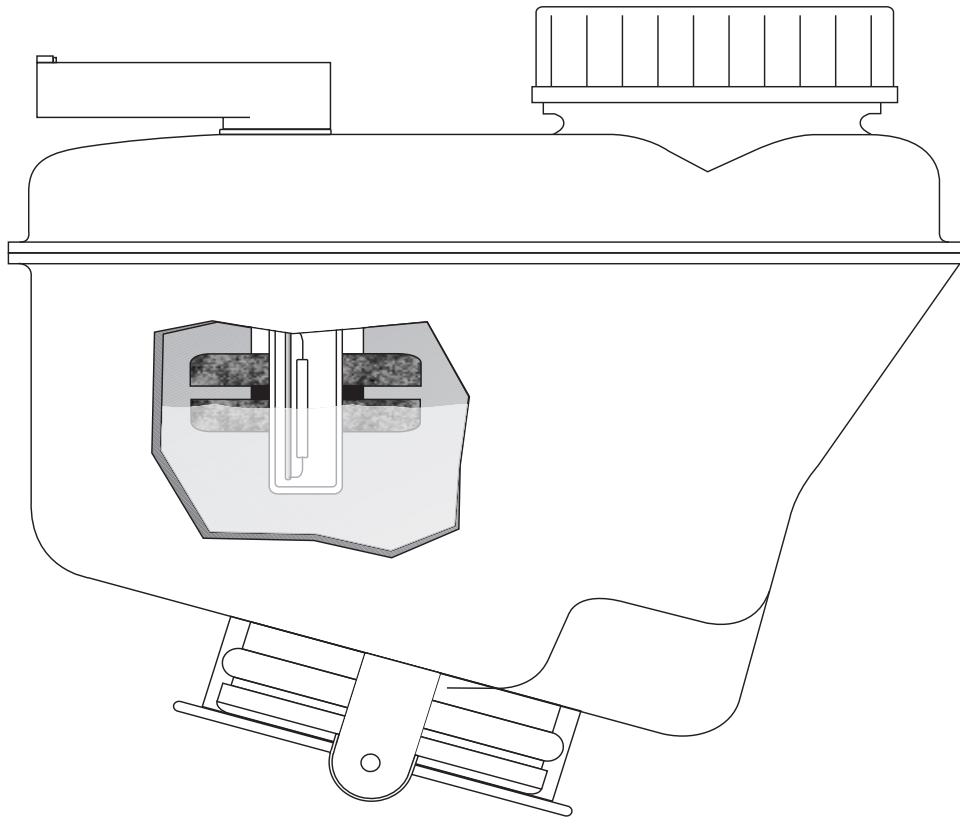
The brake light input signal is used by the control module to interrupt an ASC regulation control if the driver steps on the brakes during its operation.

This interruption does not take place during DSC regulation.

BRAKE FLUID LEVEL SWITCH

Fluid level switch is mounted in the brake master cylinder reservoir. If the fluid level is correct, the switch provides a ground signal to the DCS control module.

If the fluid level drops below the specified level, the switch opens and the ASC/DSC functions are switched off.



DSC BUTTON

The DSC system comes on every time the vehicle is switched on. The DSC button can be used to switch the system off. The warning indicator lamp comes on when the system is manually switched off

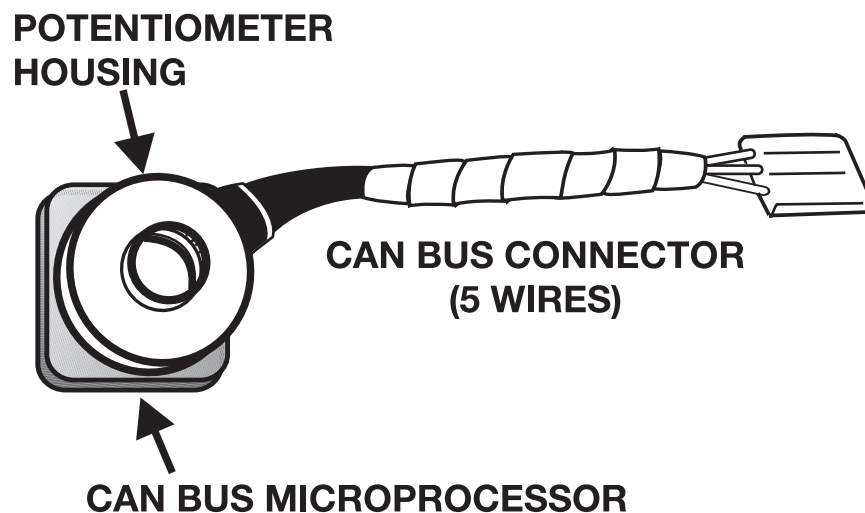


STEERING ANGLE SENSOR

The steering angle sensor is mounted at the bottom of the steering column, in front of the flexible coupling. It utilizes two potentiometers to determine steering angle and the rate of steering change. These signals are processed in the steering angle sensor and a digital output signal is passed over the CAN bus to the DSC control module.

The sensor requires calibration after repairs to the steering or suspension system. The sensor is calibrated using the DIS or MoDiC. Once calibrated, the sensor sends an ID number to the DSC control module. The ID provides confirmation to the module that the angle sensor is properly calibrated.

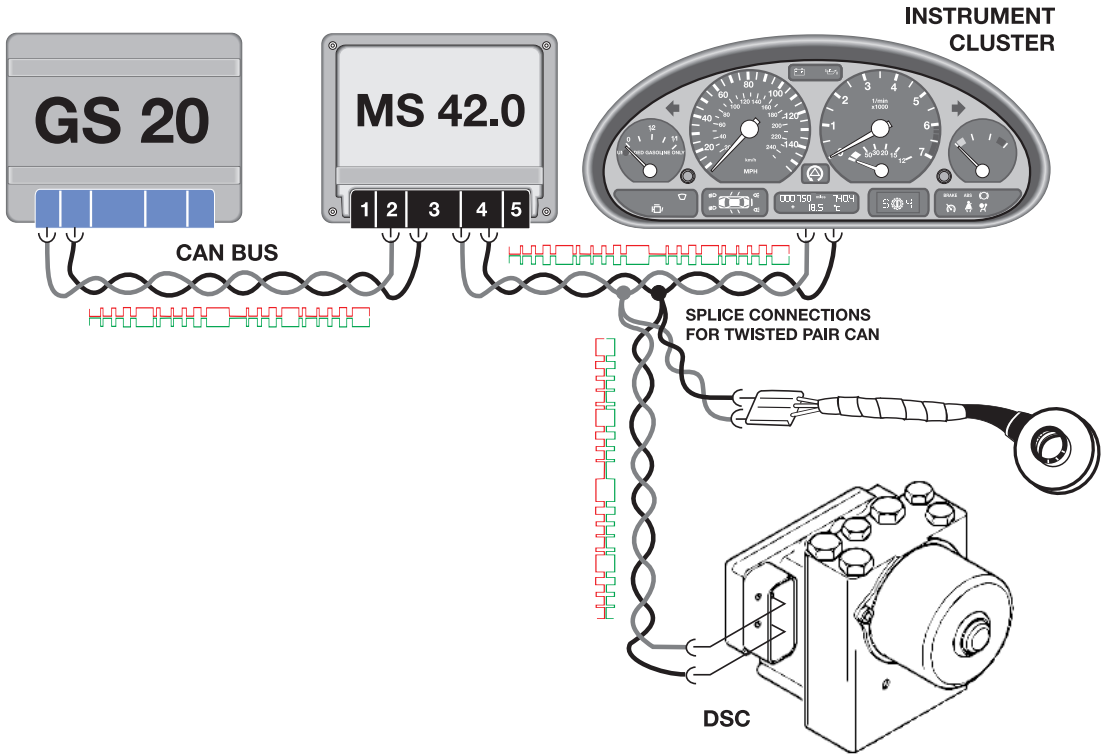
Installing a new sensor or exchanging sensors with another vehicle will require that this calibration procedure is carried out.



CAN INTERFACE

The DSC control module communicates over the CAN line for the following:

- Steering angle from the steering angle sensor
- Engine control module for engine intervention
- Transmission control module for shift intervention
- Instrument cluster for illumination of the warning indicator lamps



ROTATION RATE SENSOR

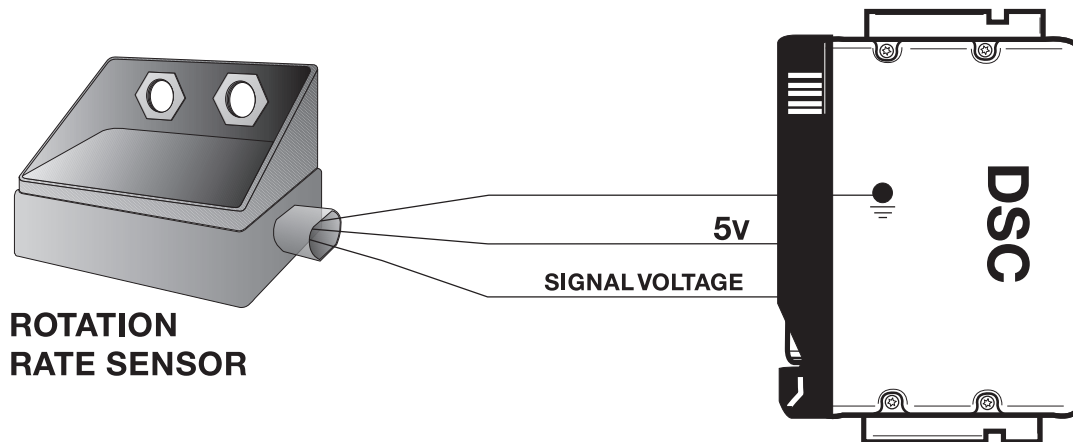
The rotational rate sensor is mounted under the driver's seat. It provides a signal to the DSC control module that corresponds to the vehicle's rotational speed around its axis (yaw speed).

The sensor receives its operating power (5 volts) from the DSC control module and provides an output voltage of approx. 0.25 to 4.65 volts depending on the amount of yaw exerted on the vehicle.

The sensor operates on the Coriolis effect to produce the output voltage. The element of the sensor is a micromechanical double quartz tuning fork. A frequency of 11 Hertz is applied to one side of the fork and as the vehicle turns on its axis, vibrations are induced into the tips at the other end.

The sensor processes the signals produced by the fork and produces an analog voltage signal that is proportional to the amount of yaw.

Based on the control module's programming parameters, the DSC will activate a DSC regulation cycle to ensure that the vehicle remains stable under all driving conditions.



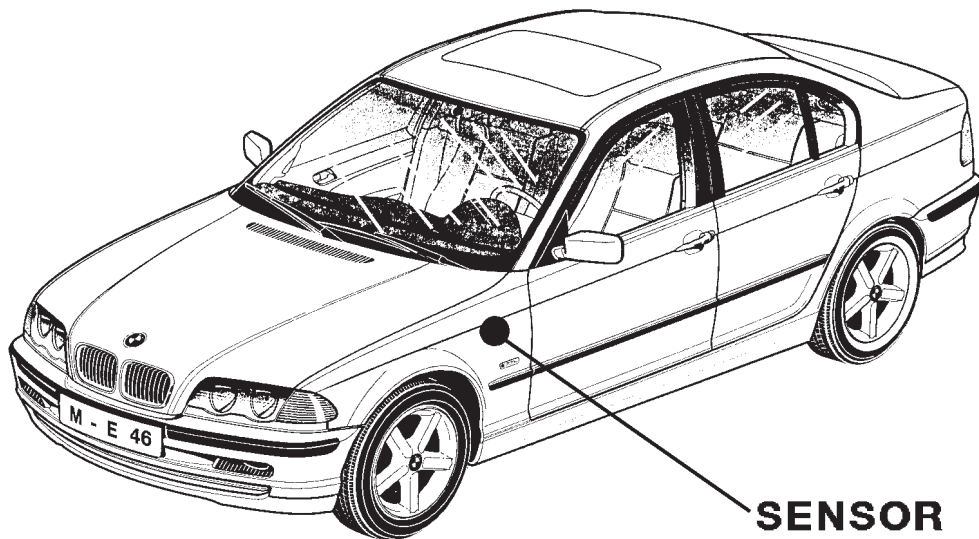
LATERAL ACCELERATION SENSOR

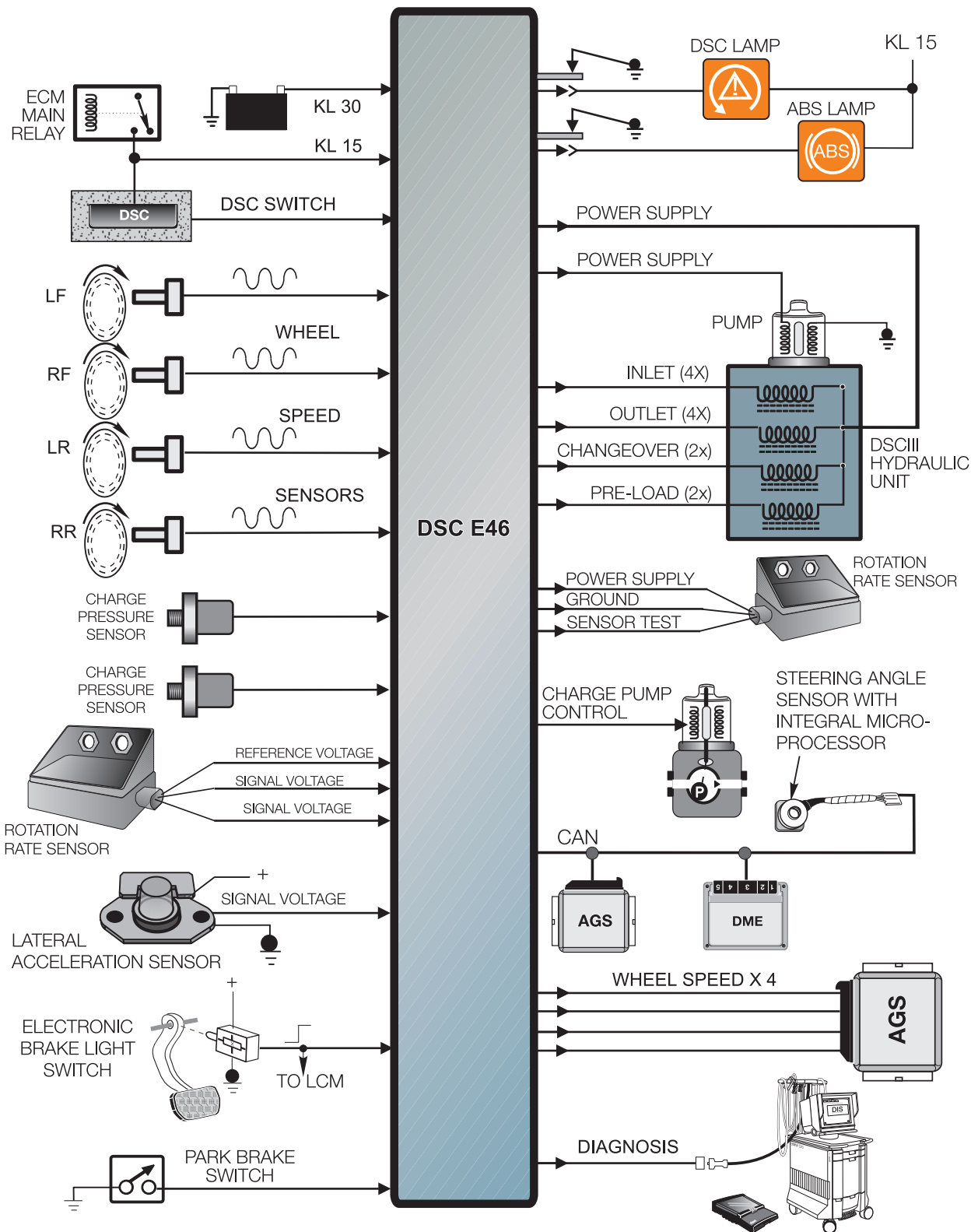
The lateral acceleration sensor is mounted in the left "A" pillar. The sensor provides the DSC control module with an input signal that corresponds to the degree of lateral acceleration ("G" forces) acting on the vehicle.

The sensor is a capacitive type with two capacitive plates (one fixed and one moving). Under the effect of lateral acceleration, the one plate moves in relation to the fixed plate. This results in a voltage signal being produced in proportion to the degree of lateral acceleration.

The voltage signal output of the sensor to the DSC control module ranges from 0.5 to 4.5 volts. When the vehicle is stationary, The standing voltage from the sensor is approximately 1.8 volts.

This signal is used in conjunction with the yaw sensor input to determine the degree of DSC regulation required to maintain the vehicle's stability.





HYDRAULIC SYSTEM COMPONENTS

CHARGE PUMP

the charge pump is installed between the master cylinder and the brake fluid reservoir. During DSC controlled regulations that involve brake intervention, the charge pump ensures that the required volume of fluid is available for the hydraulic unit.

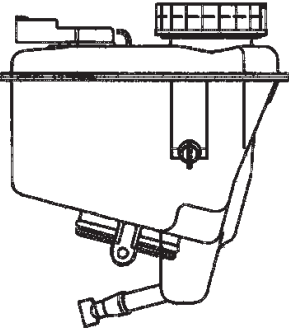
When activated, the charge pump draws fluid from the reservoir and delivers it to the master cylinder at a pressure of 10 Bar.



MASTER CYLINDER/FLUID RESERVOIR

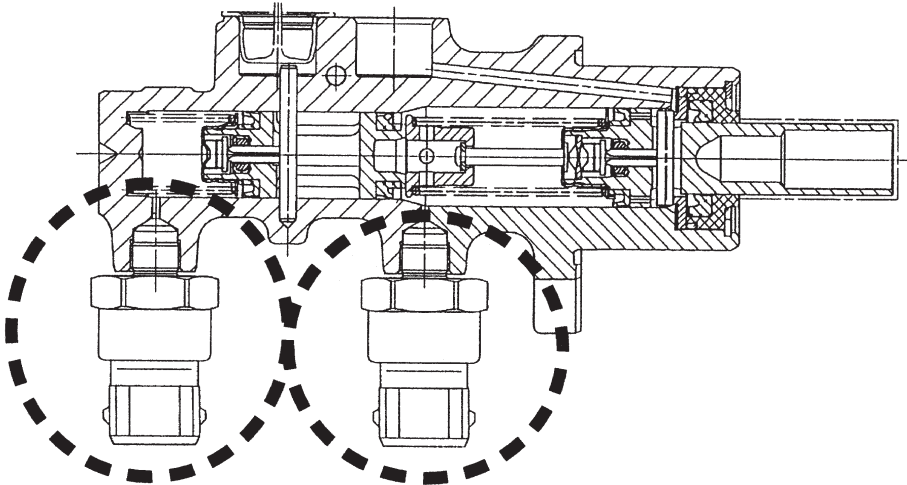
The master cylinder contains the central valves in both the front and rear brake circuits, Similar to the Bosch DSC system. The central valves allow fluid to transfer during DSC controlled interventions.

The brake fluid reservoir has internal baffles that minimize fluid foaming during controlled interventions. The charge pump pick up is mounted low on the reservoir to prevent air from entering the system during regulation. The fluid level switch will signal the control module to cancel DSC regulation if the fluid is below the safety margin level.



PRESSURE SENSORS

Two pressure sensors are installed on the master cylinder in the outlet ports for the front and rear brake circuits. The sensors provide the DSC control module with an analog voltage signal in proportion to the brake pressure in the master cylinder.



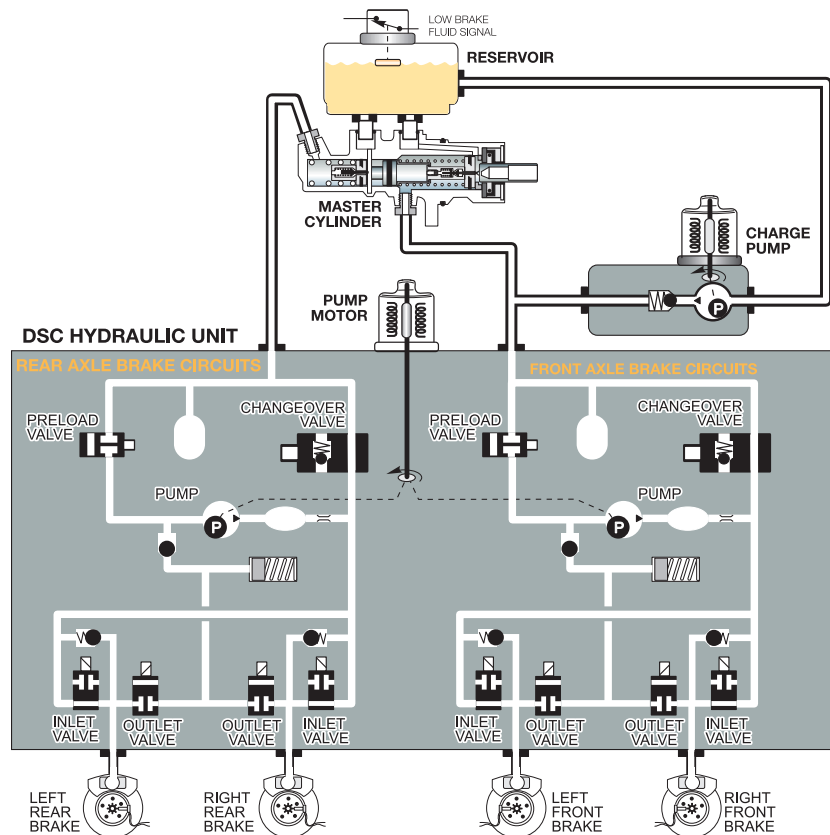
DSC HYDRAULIC OPERATION

Based on the programming of the DSC control module, hydraulic intervention can be activated at any wheel brake as follows:

- ABS regulation for any wheel that is in danger of locking - causing the wheel to skid.
- ASC regulation for either or both rear wheels to ensure that the optimum traction is applied to the drive wheels.
- DSC regulation for any wheel to correct for dynamic forces that are causing the vehicle to become unstable. The DSC intervention only takes place on one wheel of a corresponding axle.

Depending on the hydraulic intervention required, the charge pump, return pump, change-over valves, charging valves, inlet and outlet solenoids are activated to provide:

- Pressure build up for brake application
- Pressure hold to slow or stop the wheel
- Pressure release to allow the wheel to turn



DIAGNOSIS

Troubleshooting the E46 TEVES DSC system is carried out using the DIS or MoDiC.

The fault indicators in the instrument panel will illuminate when there is a fault and the system is off-line.

Follow the diagnostic procedures as outlined with the tester to troubleshoot the E46 Teves DSC system.

